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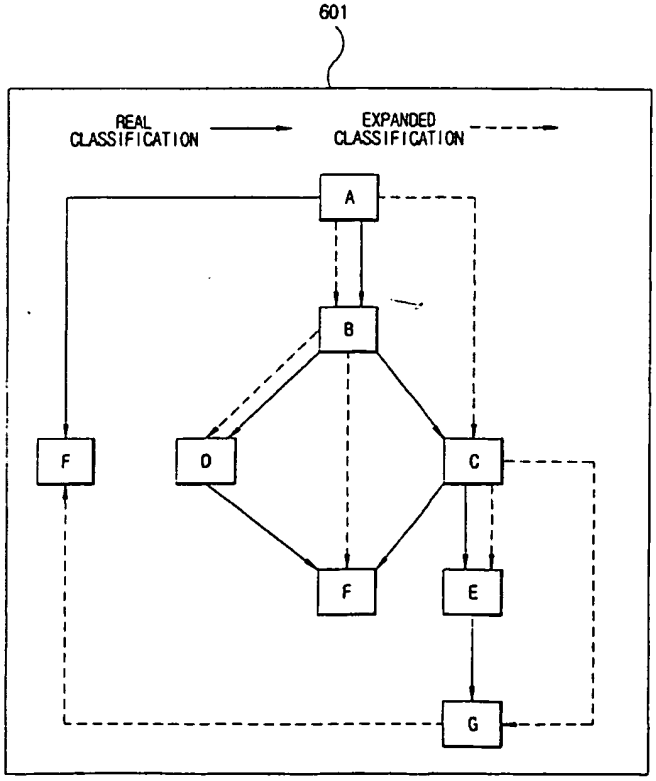

(57) Abstract: The present invention relates to a search algorithm for increasing the search efficiency of an Internet search engine. According to the present invention, an installer sets up a basis classification system and regards a classification item as a fuzzy set having a search word as an element, calculates a fuzzy degree about each search result, which belong to each classification item, calculates an inclusive relationship between the classification items as the degree a predetermined truth value and a predetermined false value, calculates a similar expanded classification system according to the degree, extracts the first search result of the search word from a database about the classification item in the basis classification system, and if user does not satisfy the first search result, then extracts repeatedly the second search result of the search word from a database about the similar expanded classification item in the similar expanded classification system until the second search result is satisfied.

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A METHOD AND SYSTEM FOR SEARCHING BY USING FUZZY RELATIONAL PRODUCTS

TECHNICAL FIELD

The present invention relates to a search algorithm for increasing search efficiency of an Internet search engine, and in more detail, a search method and apparatus for making a similar relationship regarding Internet search classifications by using fuzzy 0 products.

BACKGROUND OF THE INVENTION

"Fuzzy" is defined as 'knowledge of degree' because it deals the degree of truth. That is, fuzzy is the knowledge that overcomes the limits of Boolean logic by the traditional computer. Fuzzy handles the Boolean logic of '0' and '1' specifically.

The idea of fuzzy logic was introduced by Dr. Lotfi Zadeh of the University of California at Berkeley in the 1960's. He studied the problem how a computer can understand natural language and perceived the truth that it could not express various words specifically by using the absolute expression of '0' or '1'. The study, which was started based on the question "How pretty is my wife?", was called "computation with words" because a human's natural expression is computerized. That is, upon analysis if we indicate "She is pretty" as "1" and "She isn't pretty" as "0", then "She is slightly

pretty" may be "0.2" and "She is somewhat pretty" may be "0.5" and "She is very pretty" may be "0.8". We call "0.2", "0.5", "0.8" as membership grades. Also, because they are distinguished from the absolute expression, we call them soft computing. Of course, people would have difficulty to express sentences of daily life as '0' or '1' absolutely.

Fuzzy logic comprises '0' and '1' in the extreme case. Also, fuzzy logic comprises all values between '0'(false) and '1'(true). Therefore, fuzzy logic indicates knowledge by vagueness with the results comprising minute errors. Approximate reasoning originated from fuzzy logic. Also, fuzzy logic uses alpha-cut(-cut) in order to set a permissible limit of the errors. Because fuzzy logic is like the process of the human thinking and comprises many philosophical elements, it can be defined as the logic of emancipation to exclude some extreme thinking like Buddhistic theory. That is, the fuzzy logic is even more similar to the way of oriental thinking.

The fuzzy logic seems similar to the working method of our brain. We receive data, calculate the amount of partial truth, organize the high-level truths in order, and elevate the result as the reaction of the exercise nerve when it exceeds a threshold. This process can occur in the mechanical brain, the nervous system, and the expert system.

The present invention relates to the search algorithm of a search engine. Hereinafter, we will explain the search method, along with the advantages and disadvantages of the prior search engines.

Search engines are classified into the classification item search, the index search, the meta search that uses a plurality of search engines at once, and etc. The classification item search is the search method of constructing a directory database, and the index search is the search method of indexing documents. In the classification item search, the accuracy rate is high but the reproducibility is low. To the contrary in the index search, the accuracy rate is low but the reproducibility is high.

A representative search engine using the classification item search method is Yahoo, and a representative search engine using the index search method is AltaVista. Simmani, a real Korean search engine, uses both the classification item search method and the index search method.

We will compare the classification item search method with the index search method by referring to the following table.

	Classification item search method	Index search method
Characteristic	It registers websites according to each classification item. It looks for words corresponding to the search word in the classification item.	It lists sites that the inputted keyword has a higher priority order in the index list indexed by keyword.
Merits	Because it narrows documents	If subject and search word are

	about a correct subject, if the documents are classified correctly, then it has good search efficiency.	vague, then it looks for all websites corresponding to all search words, which are input by the user. So search area is too broad.
Demerits	If document cannot be classified into correct classification item, then it is hard to look for the document.	Because it outputs quite broad search results, the efficiency of the search engine is low.

As described above, the two search methods have sides that supplement each other. Almost all prior search engines provide two search methods together. That is, if the user is not satisfied with the search result, then he can select the other search method by using the search method option. Therefore, the prior search engines are still somewhat troublesomeness and cannot unify the merits of each search method.

In the prior index search method, more time is required in order for the user to select a desired website from voluminous search results. Also, in the prior index search method, if the desired website is in another classification, then the user cannot readily find this website.

Therefore, one object of the present invention is to provide a method and

system for setting up a relationship among each classification, multiplying the classification of the document or website, and increasing the search efficiency of the classification item search by using fuzzy relational products. A second object of the present invention is to provide a search method and system by using fuzzy relational products for making a search easy by increasing classifications of the vague search word. A third object of the present invention is to provide a search method and system by using fuzzy relational products for managing the search classification system efficiently by providing shared classification items and fluidity of classification levels. A fourth object of the present invention is to provide a search method and system by using fuzzy relational products for changing the classification system variously by setting up the permitted limit of the fuzzy logic. A final object of the present invention is to provide a search method and system by using fuzzy relational products for solving particularity among the search classifications by providing compatibility. In this instance particularity means that one search classification item is both a subordinate concept and a superordinate concept of another classification item simultaneously.

SUMMARY OF THE INVENTION

To accomplish the objects of the present invention according to one preferred embodiment of the present invention, the present invention is provided for inputting a classification item and a search word from a user, calculating the fuzzy degree

according to the degree of the search word about each of the search results, which belong to the item classification, wherein the classification item is regarded as a fuzzy set having the search word as an element, calculating an inclusive relationship between the classification items of a basis classification system as the degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree, calculating a similar expanded classification system according to the degree, extracting the first search result of the search word from a database about the classification item in the basis classification system, extracting the second search result of the search word from database about the similar expanded classification item in the similar expanded classification system and displaying the first search result and the second search result.

The formula corresponding to the fuzzy relational products is $(R^{-1} < R)_{jm} = 1/N_k \sum_k (R_{jk}^{-1} \rightarrow R_{km})$, wherein k is an index of the search word, j and m are classification fuzzy sets having the search word as an element, R is a matrix in which the classification item is a column and the search word is a row and has a fuzzy value between 0 and 1 displaying the relationship between each classification and the search word, R^{-1} is a matrix in which the classification item is a row and the search word is a column, N_k is the total number of search words, R_{jk}^{-1} is the degree that search word k is included within classification item j, R_{km} is the degree that search word k is included

within classification item m, and the arrow symbol " →" is an implication operator.

The basis classification system has an inclusive relationship of high and low concepts between a plurality of classification items. A similar expanded classification system changes according to membership function data and alpha-cut, which are applied to fuzzy relational products.

To accomplish the objects of the present invention according to another preferred embodiment of the present invention, the present invention is provided for inputting a search word by the user, extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from a database, selecting the classification item, which has the highest fuzzy degree according to the degree of the search word, in the search result, calculating inclusive relationship between the classification items of basis classification system as the degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree, calculating similar expanded classification system according to the degree, extracting similar expanded classification item corresponding to the classification item by using the similar expanded classification system, extracting search results of the search word from a database about the classification item and the similar expanded classification item and displaying the search result.

The formula corresponding to the fuzzy relational products is $(R^{-1} < R)_{jm} = 1/N_k \sum_k (R_{jk}^{-1} \rightarrow R_{km})$, wherein k is an index of the search word, j and m are classification fuzzy sets having the search word as an element, R is a matrix in which the classification item is a column and the search word is a row and has a fuzzy value between 0 and 1 displaying a relationship between each classification and the search word, R^{-1} is a matrix in which the classification item is a row and the search word is a column, N_k is the total number of search words, R_{jk}^{-1} is the degree that the search word k is included within classification item j, R_{km} is the degree that the search word k is included within classification item m, and the arrow symbol "→" is an implication operator.

The basis classification system has an inclusive relationship of high and low concepts between a plurality of classification items. The similar expanded classification system changes according to the membership function data and alpha-cut, which are applied to fuzzy relational products.

To accomplish the objects of the present invention according to still another preferred embodiment of the present invention, the present invention is provided for receiving a classification item and a search word from a user, calculating the fuzzy degree according to the degree of the search word about each of the search results, which belong to the classification item, wherein the classification item is regarded as a fuzzy set having the search word as an element, calculating an inclusive relationship

between the classification items of the basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree, calculating a similar expanded classification system according to the degree, extracting the first search result of the search word from a database about the classification item in the basis classification system, extracting the second search result of the search word from the database about the similar expanded classification item in the similar expanded classification system and displaying the first search result and the second search result.

To accomplish the objects of the present invention according to still another preferred embodiment of the present invention, the present invention is provided for receiving a search word from a user, extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from a database, selecting the classification item, which has highest fuzzy degree according to the degree of the search word, in the search result, calculating an inclusive relationship between the classification items of the basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree, calculating a similar expanded classification system according to the degree, extracting a similar expanded classification item

corresponding to the classification item by using the similar expanded classification system, extracting search results of the search word from a database about the classification item and the similar expanded classification item and displaying the search results.

BRIEF DESCRIPTIONS OF THE DRAWINGS

The above objects and other advantages of the present invention will become more apparent by detailed descriptions of the preferred embodiments thereof with reference to the attached drawings, in which:

FIG. 1 is a schematic diagram of a search system for making similar relationships among search classifications by using fuzzy relational products in the present invention.

FIG. 2 is a functional block diagram of making similar relationships among search classifications by using fuzzy relational products in the present invention.

FIG. 3 is a diagram of result lists created by an implication operator in the present invention.

FIG. 4 is a diagram of applying fuzzy relational products to a search classification item in the present invention.

FIG. 5a and FIG. 5b are the results according to alpha-cut(α-cut) in the present invention.

FIG. 6 is an example illustrating real classification and expanded classification according to the fuzzy relational method in the present invention.

FIG. 7 is a diagram illustrating a classification system of the expanded classification according to the fuzzy relational method in the present invention.

FIG. 8 is a flowchart illustrating the process of making a similar relationship among search classifications and searching by using fuzzy relational products in the present invention.

<A key of numerical references for the major parts of the drawings>

101: search server

103: fuzzy search module

107: database server

109: search information database

111: network

113: user computer

115: manager computer

EMBODIMENT

Hereinafter, preferred embodiments of the present invention will be described in more detail with reference to the accompanying drawings, but it is understood that

the present invention should not be limited to the following embodiments.

FIG. 1 is a schematic diagram of a search system for making similar relationships among search classifications by using fuzzy relational products in the present invention. Referring to FIG. 1, a search server 101 comprises a fuzzy search module 103 that provides a search according to the similar relationship among search classifications by using fuzzy relational products. We will explain the search method according to fuzzy relational products between FIG. 3 and FIG. 8.

The database server 107, which is coupled with a search server 101, comprises a search information database 109. The search information database 109 comprises a search word table 121, classification item table 123, fuzzy degree table 125, etc. Keywords are stored on the search word table 121, and the classification items of the basis classification system are stored on the classification item table 123. Fuzzy degrees are stored on the fuzzy degree table 125. The fuzzy degree is calculated for each search result belonging to each classification item, which is regarded as a fuzzy set comprising a search word as an element, according to the frequency of the search word.

Manager 119 and user 115 connect to the search server 101 through network 111 by using the manager computer 117 and the user computer 113 equipping a web browser.

Fuzzy logic was suggested as a possibility (the logic value between 0 and 1) in order to apply the logic of vague reality about the crisp logic value, which is fixed as [0,

1] by Zadeh. The vagueness is caused by not only changeability of the logical subject but also unreality of the crisp logic value. Fuzzy logic can apply the unreal human logic to real life by breaking the crisp concept of logic value and becoming a logic value between 0 and 1.

Fuzzy logic was introduced by Zadeh, developed by many researchers especially mathematicians, and applied to real life in Japan. Fuzzy logic is used in order to improve the resolution of a camera and applied to a mechanical brain of a washing machine, a refrigerator, and an air conditioner. That is, it need not be asserted that fuzzy logic is the seed of the mechanical brain algorithm.

Also, fuzzy logic can be applied to the relational database, the object-oriented database, and etc. Fuzzy logic can be used in order to set up the vagueness of a relationship at the relational database and set up the obscurity of the class hierarchy structure. Fuzzy logic may be widely applied to setting up the relationship of objects. The relationship of objects is usually described as the inclusive relationship. And the relational products describe it well.

Each classification is regarded as a fuzzy set having a search word as an element at the predetermined basis classification system. A fuzzy degree is decided according to the frequency of a search word in documents or the summary of web sites corresponding to each classification. And the fuzzy search module 103 displays the inclusive relationship as a value between 0 and 1 by using the fuzzy degree and

applying fuzzy relational products to each classification.

If the fuzzy search module 103 knows the classification of a document, then it looks for the classification in the classification system display window. Also if the fuzzy search module 103 cannot search for the desired content in the classification, then expansion occurs into similar classifications.

If the classification is not correct, then the fuzzy search module 103 selects the classification of high degree in the classifications, which are related to the search word, and displays it. Also if the fuzzy search module 103 cannot search for the desired content in the classification, then it expands to similar classifications.

FIG. 2 is a functional block diagram for making a similar relationship among search classifications by using fuzzy relational products in the present invention. Referring to FIG. 2, the search condition, which is received by the user 115, is transmitted to the database process and fuzzy search unit 207. The search condition can be a classification item or a search word. The database process and fuzzy search unit 207 searches the search word about the classification item on the search information database 109 and displays the search result 203.

The database process and fuzzy search unit 207 extracts search words and classification items and then calculates fuzzy degree information between each search word and each classification item. Also, the database process and fuzzy search unit 207 calculates the expanded similar classification item by applying the classification item to

fuzzy relational products. And the database process and fuzzy search unit 207 searches the search word about each expanded similar classification item and displays the search result 203.

FIG. 3 is a diagram of result lists created by an implication operator in the present invention. Referring to FIG. 3 and regarding the general concept of a set, whether the element x is comprised in set A($x \in A$) is displayed as 0 or 1 according to the crisp logic. However, if A is a fuzzy set, then the logical value of $x \in A$ can be a value between 0 and 1.

Also, the crisp implication operator has values as follows.

	0
0	0
1	1

If fuzzy logic applies a fuzzy set, fuzzy power set, and crisp implication operator, then a binary function is needed, which outputs the result in the range of [0,1] and the domain of $[0,1]\times[0,1]$. We name the function implication operator and can display various types according to each environment. Hundreds of kinds of known implication operators exist.

The representative functions are as follows.

KD. The Kleene-Diense systems and operator

$a \rightarrow b = (1-a) \vee b = \max(1-a,b)$

Implication operator is the function for setting logical value of fuzzy implication. From this, we can display an inclusive relationship of all elements, which are comprised in the universal set, as shown in Table 301(Degree of membership).

FIG. 4 is a diagram of applying fuzzy relational products to search a classification item in the present invention. We will examine first about fuzzy relational products in order to explain how these fuzzy relational products are applied to the search classification item. Referring to FIG. 4, fuzzy relational products were developed for the first time by W. Bandler and L.J. Kohout. Some fuzzy relational products were applied to establish a relationship between each of the patients by observing Parkinson's disease patients' mental symptoms in London hospitals in order to handle the possibility in the actual world.

The formula that works by fuzzy relational products is as follows.

$$(R^{(2)\text{-}1}(t) < R^{(1)}(t))_{jm} - 1/N_k \sum_k (R_{jk}{}^{(2)\text{-}1}(t) \rightarrow R^{(1)}{}_{km}(t)) \qquad \text{formula 1)}$$

Usually, search classification items become involved as an inclusive relationship of high and low concepts. In the crisp environment, some classification item has a classification of a subordinate concept like book classification of the library. Therefore, high position classification item includes each low rank classification item that the classification item of a subordinate concept includes. But the high and low inclusive relationship can appear to be more or less different according to the subjective viewpoint of the actual search subject.

When we look from the viewpoint of an ordinary person, we think of the Internet as that which is obviously seen on the web pages that are searched through a web browser. Contrarily from the expert's viewpoint, the Internet comprises terminology that not only indicates the world wide web (WWW) but also communication protocols such as FTP, Gopher, News, Email and so on. We embody fluid classification system that changes according to the search environment and search subject by applying fuzzy relational products in order to process vagueness of inclusive relationships, uncertainty, and variability.

First, there is need to establish a relationship between a classification item and search words. A keyword (which is related to the classification item) besides the classification item itself does not exist in the typical search engine. In the present invention, some search words of each classification are related to a degree that has a value between 0 and 1.

As an example we are going to explain the search classification method in fuzzy relational products by using formula 1.

Supposition)

1) K1, K2, K3, K4, K5: search word

2) C1, C2, C3, C4, C5: fuzzy set that has the search word as an element

3) R: matrix in which classification is a column and search word is a row and displays a relationship between each classification and search word. It has a

fuzzy value between 0 and 1.

4) R^{-1}: matrix in which classification is a row and search word is a column.

The lower formula is calculated by the above supposition and formula 1.

$$(R^{-1} < R)_{jm} = 1/N_k \sum_k (R_{jk}^{-1} \rightarrow R_{km}) \qquad \text{formula 2)}$$

N_k: total number of search words

R_{jk}^{-1}: degree that search word k is included within classification item j

R_{km}: degree that search word k is included within classification item m

Arrow symbol "→" : implication operator

The formula 2 indicates the degree that the m times classification set comprises search words of the j times classification set.

Example) $(R^{-1} < R)_{23} = 1$, $(R^{-1} < R)_{13} = 0.8$

Then the relationship between each classification can be set up like 401, 403 and 405 by fuzzy relational products. Alpha-cut (α-cut) is a stand value to change the final result to a crisp value. That is, if alpha-cut(α-cut) is 1, then the relational products value which is less than or equal to 0.8 becomes 0, and the relational products value which is over 0.8 becomes 1. If alpha-cut(α-cut) is 0.8, then relational products value which is below 0.8 becomes 0, and the relational products value which is greater than or equal to 0.8 becomes 1.

FIG. 5a and FIG. 5b illustrate the results according to alpha-cut(α-cut) in the present invention. Referring to FIG. 5a and FIG. 5b, the relationship between search

classification items is created by the final value, which is made by the fuzzy relational products at FIG. 4. The schematic diagram displaying relationship between search classification items is same with 501 when alpha-cut is 1. Also, the schematic diagram displaying a relationship between search classification items is the same with 503 when alpha-cut is 0.8.

When alpha-cut is 1 like 501, classification item C1 is a subordinate item of all classification items, and C3 is a subordinate classification item of C2, and C5 is a subordinate classification item of C4.

When alpha-cut is 0.8 like 503 C4 is the highest classification item, and C1 and C3 are the lowest classification items. The classification relationship of alpha-cut 0.8 expands comprising the classification relationship of alpha-cut 1.

We can find some particularity being different from the general search classification in 501 and 503.

1) Share of classification: C1 is composed simultaneously of subordinate classification items of C2, C3, C4 and C5 in 501. The search method of the present invention introduces a share concept and multi-inheritance instead of an exclusive concept of general search classification. That is, the sites that are classified by C1 share C2, C3, C4, and C5 as a high position classification item.

2) Fluidity of classification : C1 has fluidity that can be situated in several classification hierarchies in 501. C1 belongs in the third classification hierarchy when

the search path is C2 → C3 → C1. However, C1 belongs in the second classification hierarchy when search path is C2 → C1.

3) Representation of more than two about one meaning: We can find another particularity in 503. C1, C3 are expressed differently as a search classification having the same meaning. That is, C1 and C3 are equal for all classification relationships.

4) Compatibility of classification: C2 and C5 to each other are both a subordinate concept and a superordinate concept in 503 at the same time. However, C2 and C5 do not represent the same meaning as the relationship of C1 and C3. C5 is a subordinate classification of C1 and C3, but C2 is not. This situation is similarly explained for the relationship of C1, C3, C5.

5) Subjectivity of classification system: The classification system can be different according to alpha-cut in 501 and 503. The alpha-cut can change according to the search environment and search subject.

FIG. 6 is an example illustrating real classification and expanded classification according to the fuzzy relational method in the present invention. FIG. 7 is a diagram illustrating the classification system of the expanded classification according to the fuzzy relational method in the present invention.

Referring to FIG. 6 and FIG. 7, the inclusive relationship between search classifications A, B, C, D, E, F, G is marked with a solid line in 601. Furthermore, the expanded classification relationship, which is created by fuzzy relational products, is

marked with dotted line in 601. That is, the expanded classification relationship, which is created by fuzzy relational products, among search classifications A, B, C, D, E, F, G can be expressed the same with 701.

FIG. 8 is a flowchart illustrating the process of making similar relationships among search classifications and searching by using fuzzy relational products in the present invention. Referring to FIG. 8, if the fuzzy search module 103 receives a classification item and search word from user 115 S801, then the fuzzy search module 103 extracts the subordinate classification item corresponding to the classification item from a search information database 109 S803. And the fuzzy search module 103 extracts the similar expanded classification item of the classification item and the similar expanded classification item of the subordinate classification item according to fuzzy relational products S805. If the fuzzy search module 103 extracts the search classification item and the similar expanded classification item, then finds the search word about each classification item S807.

In more detail, the search order by the search system, which supports fuzzy relational products, is as follows. The user expands the search tree until he looks for the desired search classification in the user interface screen of the tree view type. Otherwise, the user inputs a search classification item in the search word input part and pushes the

return key; thereafter the fuzzy search module 103 unfolds the classification items automatically in the user interface screen of the tree view type. Whenever the user selects a classification item in the tree view, the summary explanation of sites, which belong directly to the classification, can be displayed on another window.

If the user selects the summary explanation window, he then connects with the site automatically. Also the fuzzy search module 103 modifies the statistics data of the selection count.

If the desired site does not exist in the classification or the subordinate classification, then the user selects the option for expanding to the similar classification. Then the fuzzy search module 103 extracts the similar expanded classification item by using fuzzy relational products and searches the search word in the similar expanded classification item.

INDUSTRIAL APPLICABILITY

As described above, according to the present invention, the present invention can provide a method and system for setting up the relationship among each classification, multiplying the classification of a document or website and increasing the search efficiency of the classification item search by using fuzzy relational products.

Also, the present invention can provide a search method and system by using fuzzy relational products for making the search easy by increasing the number of classifications of the vague search word.

Also, the present invention can provide a search method and system by using fuzzy relational products for managing the search classification system efficiently by providing for sharing of classifications and fluidity of classification levels.

Also, the present invention can provide a search method and system by using fuzzy relational products for changing the classification system variously by setting up the permitted limit of the fuzzy logic.

Also, the present invention can provide a search method and system by using fuzzy relational products for solving the particularity among the search classifications by providing compatibility. The particularity means that one search classification item is a subordinate concept and a superordinate concept of another classification item simultaneously.

Also, the present invention can provide a search method and system by using fuzzy relational products for being utilized as a basis module of an intelligent classification way, as well as a search engine.

Also, the present invention can provide a search method and system by using

fuzzy relational products for providing a search way uniting the advantages of a classification item search and the index search through the excellent graphical user interface of a tree view type.

What is claimed is

1. A method for providing a search by forming similar relationship between search classifications, having a basis classification system composed of a plurality of classification items and comprising the steps of:

inputting a classification item and a search word from user;

calculating a fuzzy degree according to the degree of the search word about each search result, which belong to the classification item, wherein the classification item is regarded as a fuzzy set having the search word as an element;

calculating an inclusive relationship between the classification items of a basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

calculating a similar expanded classification system according to the degree;

extracting the first search result of the search word from a database about the classification item in the basis classification system;

extracting the second search result of the search word from a database about the similar expanded classification item in the similar expanded classification system; and

displaying the first search result and the second search result.

2. The method of claim 1, wherein the formula corresponding to the fuzzy relational products is $(R^{-1} < R)_{jm} = 1/N_k \sum_k (R_{jk}^{-1} \rightarrow R_{km})$, wherein k is an index of the search word,

j and m are classification fuzzy sets having the search word as an element,

R is a matrix in which the classification item is a column and the search word is a row and has a fuzzy value between 0 and 1 displaying a relationship between each classification and the search word,

R^{-1} is a matrix in which the classification item is a row and the search word is a column,

N_k is a total number of search words,

R_{jk}^{-1} is a degree that search word k is included within classification item j,

R_{km} is a degree that search word k is included within classification item m, and

an arrow symbol "→" is an implication operator.

3. The method of claim 1, wherein the basis classification system has an inclusive relationship of high and low concepts between a plurality of classification items.

4. The method of claim 1, wherein the similar expanded classification system changes according to membership function data and alpha-cut, which are

applied to fuzzy relational products.

5. A method for providing a search by forming similar relationships between search classifications, having a basis classification system composed of a plurality of classification items and comprising the steps of:

inputting a search word from user;

extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from a database;

selecting the classification item, which has highest fuzzy degree according to the degree of the search word, from the search result;

calculating an inclusive relationship between the classification items of a basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

calculating a similar expanded classification system according to the degree;

extracting a similar expanded classification item corresponding to the classification item by using the similar expanded classification system;

extracting a search result of the search word from a database about the classification item and the similar expanded classification item; and

displaying the search result.

6. The method of claim 5, wherein the formula corresponding to the fuzzy relational products is $(R^{-1} < R)_{jm} = 1/N_k \sum_k (R_{jk}^{-1} \rightarrow R_{km})$, wherein k is an index of the search word,

j and m are classification fuzzy sets having the search word as an element,

R is a matrix that the classification item is a column and the search word is a row and has fuzzy value between 0 and 1 displaying a relationship between each classification and the search word,

R^{-1} is a matrix that the classification item is a row and the search word is a column,

N_k is a total number of search words,

R_{jk}^{-1} is a degree that search word k is included within classification item j,

R_{km} is a degree that search word k is included within classification item m, and an arrow symbol "→" is an implication operator.

7. The method of claim 7, wherein the basis classification system has an inclusive relationship of high and low concepts between a plurality of classification items.

8. The method of claim 5, wherein the similar expanded classification

system is changed according to membership function data and alpha-cut, which are applied to fuzzy relational products.

9. A method for providing a search by forming a similar relationship between search classifications through a network, having a basis classification system composed of a plurality of classification items and comprising the steps of:

receiving a classification item and a search word from user;

calculating fuzzy degree according to the degree of the search word about each search result, which belong to the classification item, wherein the classification item is regarded as fuzzy set having the search word as an element;

calculating an inclusive relationship between the classification items of basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

calculating a similar expanded classification system according to the degree;

extracting the first search result of the search word from a database about the classification item in the basis classification system;

extracting the second search result of the search word from a database about the similar expanded classification item in the similar expanded classification system; and

displaying the first search result and the second search result.

10. A method for providing a search by forming similar relationships between search classifications through a network, having basis classification system composed of a plurality of classification items and comprising the steps of:

receiving a search word from user;

extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from database;

selecting the classification item, which has highest fuzzy degree according to the degree of the search word, in the search result;

calculating an inclusive relationship between the classification items of a basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

calculating a similar expanded classification system according to the degree;

extracting a similar expanded classification item corresponding to the classification item by using the similar expanded classification system;

extracting a search result of the search word from a database about the classification item and the similar expanded classification item; and

displaying the search result.

11. A system for providing a search by forming similar relationships between search classifications, the system has a basis classification system composed of a plurality of classification items and comprises the steps of:

means for inputting a classification item and a search word from user;

means for calculating fuzzy degree according to the degree of the search word about each search result, which belong to the classification item, wherein the classification item is regarded as a fuzzy set having the search word as an element;

means for calculating an inclusive relationship between the classification items of basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

means for calculating similar expanded classification system according to the degree;

means for extracting the first search result of the search word from a database about the classification item in the basis classification system;

means for extracting the second search result of the search word from a database about the similar expanded classification item in the similar expanded classification system; and

means for displaying the first search result and the second search result.

12. A system for providing a search by forming similar relationships between search classifications, the system has a basis classification system composed of a plurality of classification items and comprises the steps of:

means for inputting a search word from user;

means for extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from a database;

means for selecting the classification item, which has highest fuzzy degree according to the degree of the search word, in the search result;

means for calculating an inclusive relationship between the classification items of basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

means for calculating a similar expanded classification system according to the degree;

means for extracting a similar expanded classification item corresponding to the classification item by using the similar expanded classification system;

means for extracting a search result of the search word from a database about the classification item and the similar expanded classification item; and

means for displaying the search result.

13. A system for providing a search by forming similar relationships between search classifications through a network, the system has a basis classification system composed of a plurality of classification items and comprises the steps of:

means for receiving a classification item and a search word from user;

means for calculating fuzzy degree according to the degree of the search word about each search result, which belong to the classification item, wherein the classification item is regarded as a fuzzy set having the search word as an element;

means for calculating an inclusive relationship between the classification items of a basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

means for calculating a similar expanded classification system according to the degree;

means for extracting the first search result of the search word from a database about the classification item in the basis classification system;

means for extracting the second search result of the search word from a database about the similar expanded classification item in the similar expanded classification system; and

means for displaying the first search result and the second search result.

14. A system for providing a search by forming similar relationships between search classifications through a network, the system has a basis classification system composed of a plurality of classification items and comprises the steps of:

means for receiving a search word from user;

means for extracting at least one classification item list corresponding to the search word and search result corresponding to the classification item list from a database;

means for selecting the classification item, which has highest fuzzy degree according to the degree of the search word, in the search result;

means for calculating an inclusive relationship between the classification items of basis classification system as a degree between a predetermined truth value and a predetermined false value by applying fuzzy relational products to the basis classification system by using the classification item and the fuzzy degree;

means for calculating similar expanded classification system according to the degree;

means for extracting a similar expanded classification item corresponding to the classification item by using the similar expanded classification system;

means for extracting search result of the search word from a database about the classification item and the similar expanded classification item; and

means for displaying the search result.

15. A computer-readable medium having stored thereon computer-executable instructions and realized in fact by a program of instructions, which could be executable by a digital processing unit, for performing one method of the group consisting of claims 1-8.

16. A system for providing a search by forming similar relationships between search classifications, the system comprising:

a storage device; and

a processor coupled with the storage device,

the storage device storing a program for controlling the processor; and

the processor operative with the program to perform one method of the group consisting of claims 9 - 10.

FIG. 1

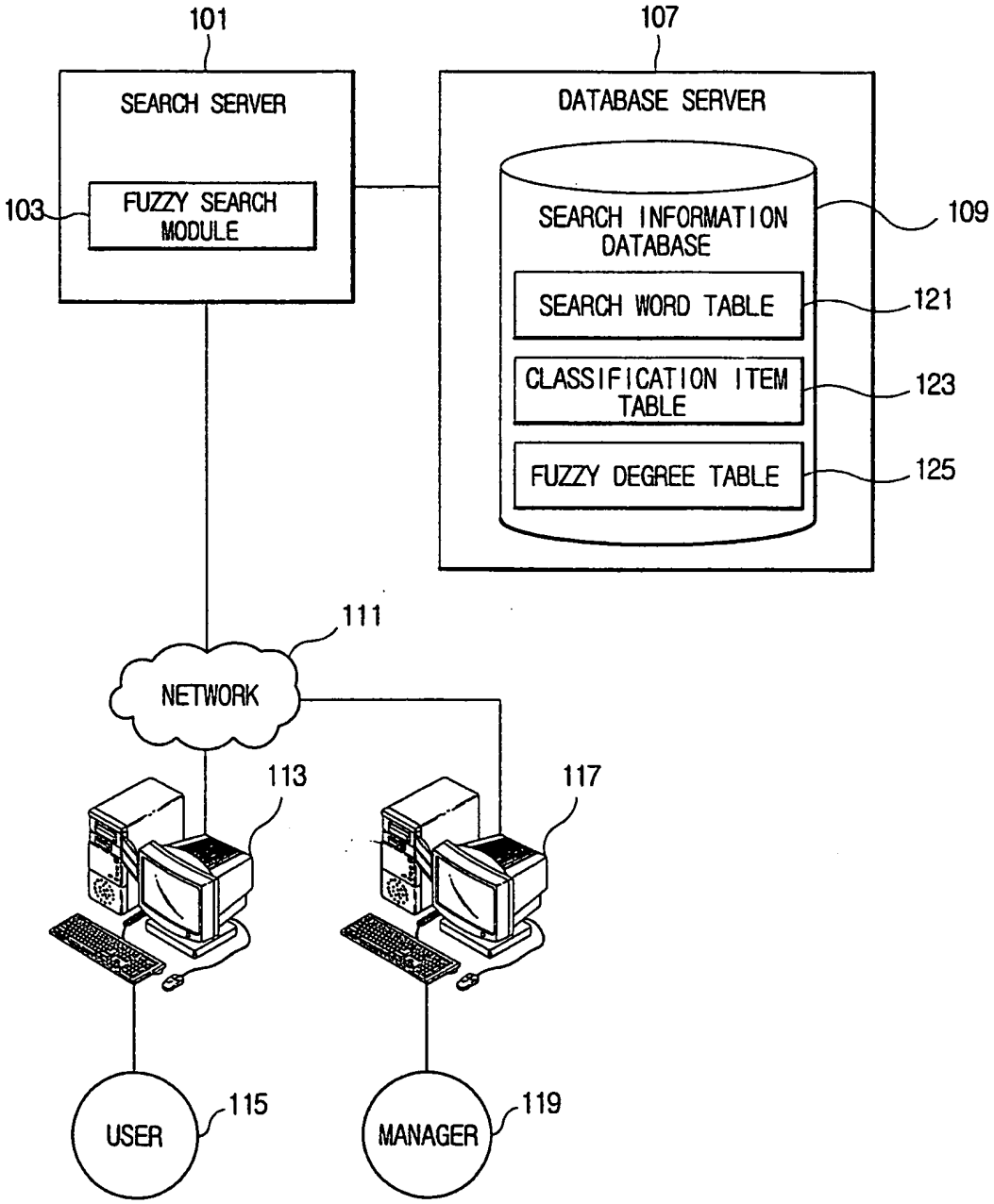
101
SEARCH SERVER
103
FUZZY SEARCH MODULE
107
DATABASE SERVER
SEARCH INFORMATION DATABASE
109
SEARCH WORD TABLE
121
CLASSIFICATION ITEM TABLE
123
FUZZY DEGREE TABLE
125
111
NETWORK
113
117
USER
115
MANAGER
119

FIG. 2

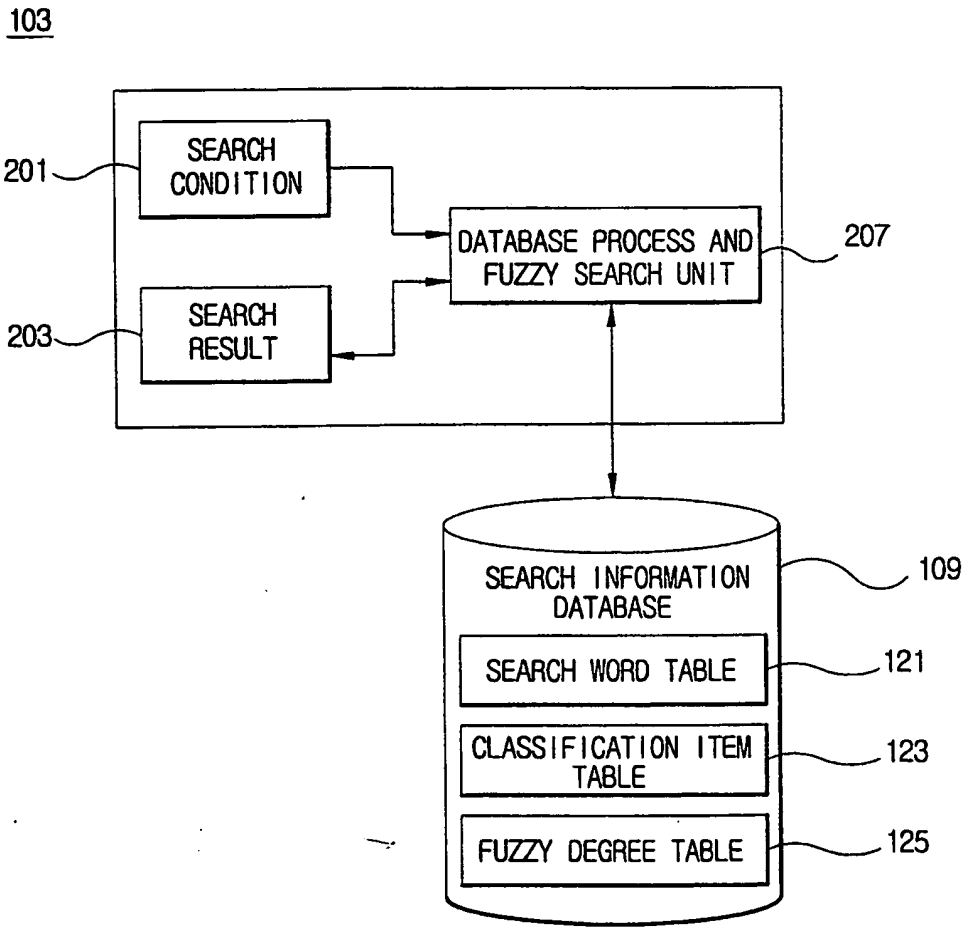
103
201
SEARCH CONDITION
203
SEARCH RESULT
DATABASE PROCESS AND FUZZY SEARCH UNIT
207
SEARCH INFORMATION DATABASE
109
SEARCH WORD TABLE
121
CLASSIFICATION ITEM TABLE
123
FUZZY DEGREE TABLE
125

FIG. 3

301

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0	1	1	1	1	1	1	1	1	1	1	1
0.1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1
0.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1
0.3	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.9	1
0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.8	0.9	1
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.8	0.9	1
0.6	0.4	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.8	0.9	1
0.7	0.3	0.3	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0.8	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0.9	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
1.0	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

FIG. 4

R^{-1}

	K1	K2	K3	K4	K5
C1	0.9	1	1	1	1
C2	0	1	0.1	0	1
C3	1	0.8	0	1	1
C4	0	0	1	0	0.1
C5	0	1	1	0.8	1

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R

	C1	C2	C3	C4	C5
K1	0.9	0	1	0	0
K2	1	1	0.8	0	1
K3	1	0.1	0	1	1
K4	1	0	1	0	0.8
K5	1	1	1	0.1	1

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$R^{-1} \triangleleft R$

	C1	C2	C3	C4	C5
C1	1	0.4	0.8	0.2	0.8
C2	1	1	1	0.6	1
C3	1	0.6	1	0.3	0.8
C4	1	0.8	0.8	1	1
C5	1	0.8	0.8	0.5	1

405

α-CUT FOR α=1

1	0	0	0	0
1	1	1	0	1
1	0	1	0	0
1	0	0	1	1
1	0	0	0	1

407

α-CUT FOR α=0.8

1	0	1	0	1
1	1	1	0	1
1	0	1	0	1
1	1	1	1	1
1	1	1	0	1

409

FIG. 5A

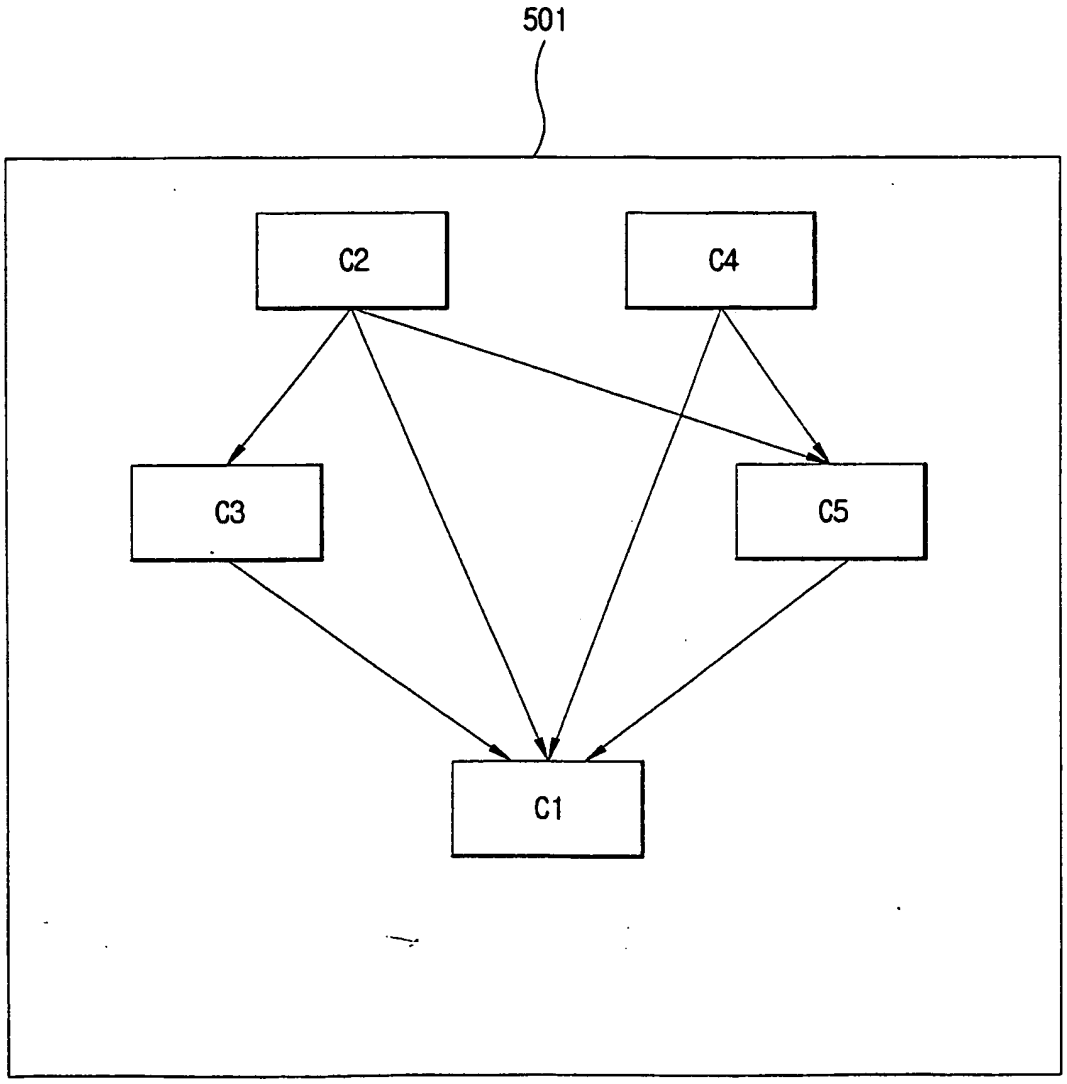
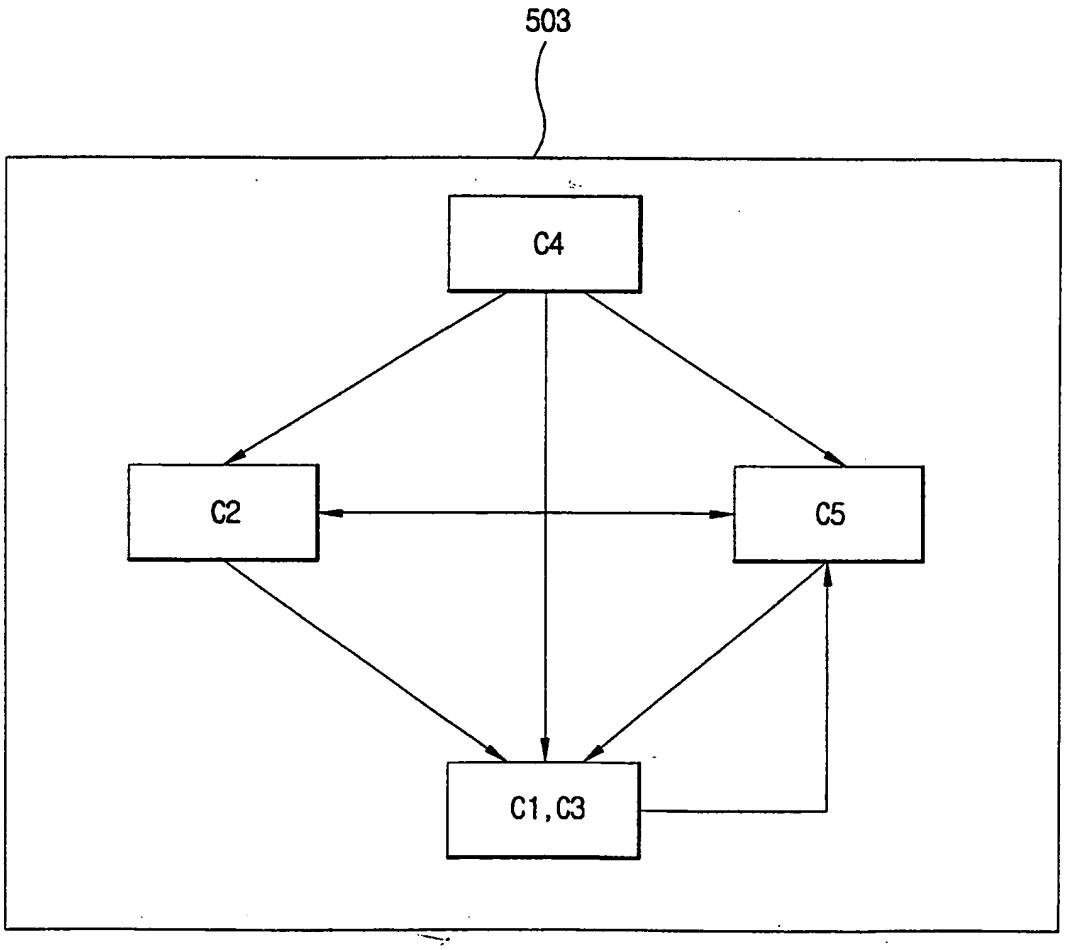


FIG. 5B



7/9
FIG. 6

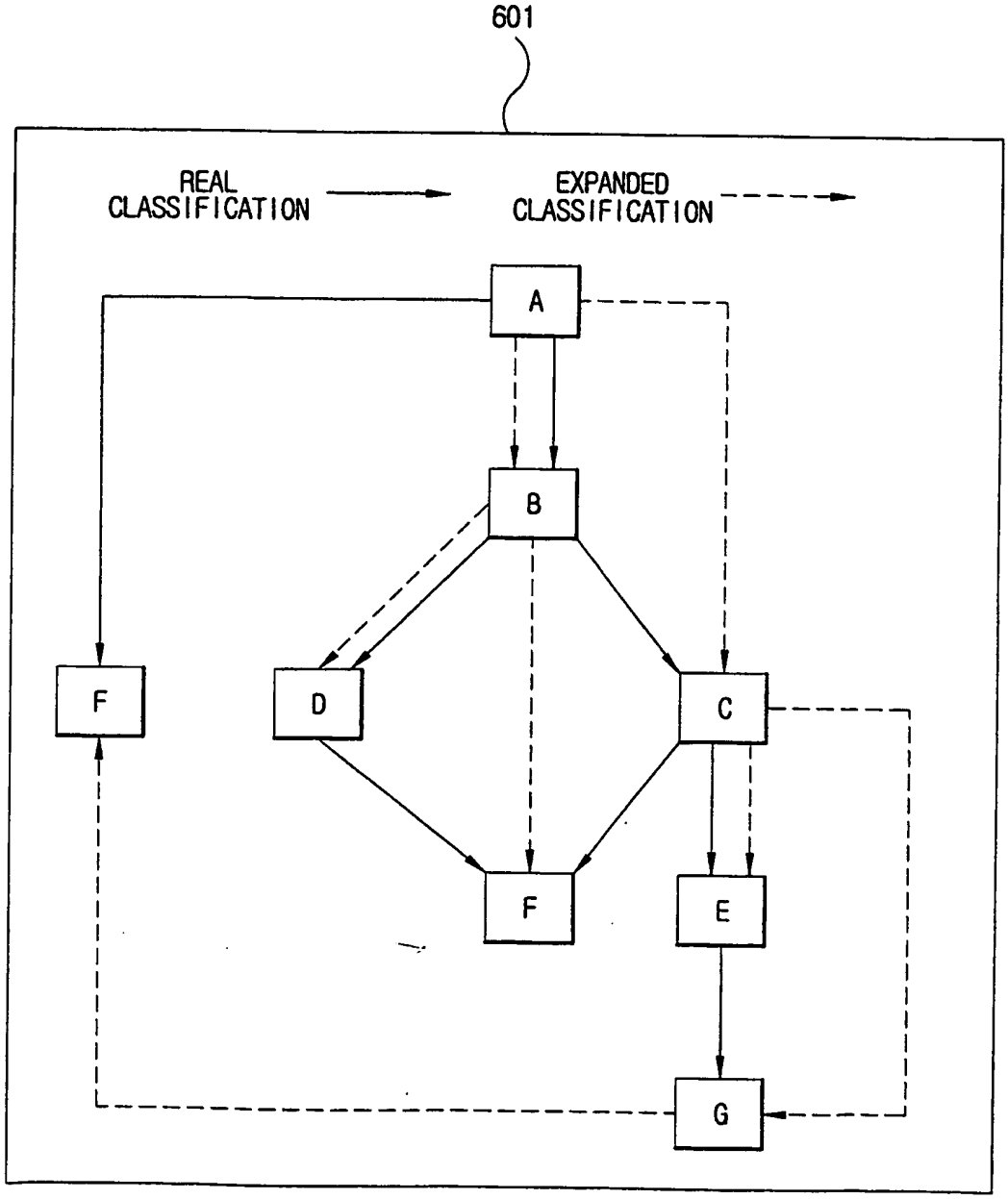

601
REAL CLASSIFICATION
EXPANDED CLASSIFICATION
A
B
F
D
C
F
E
G

FIG. 7

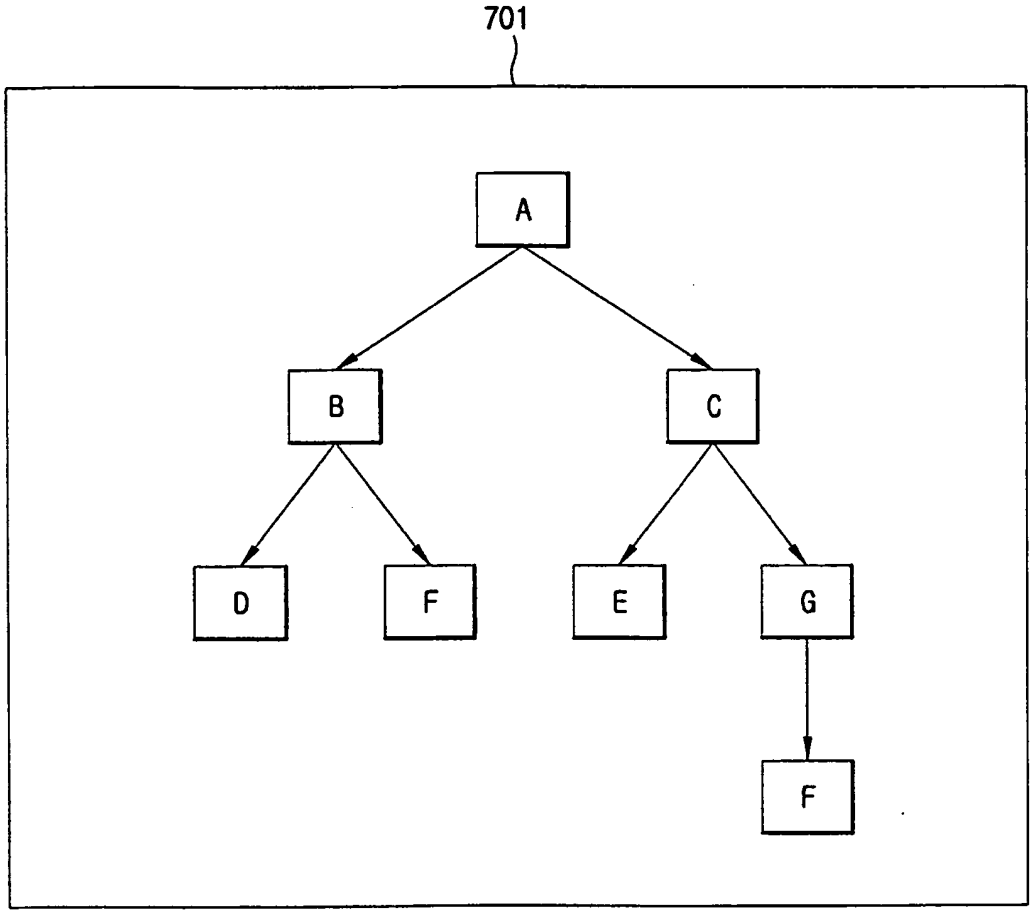
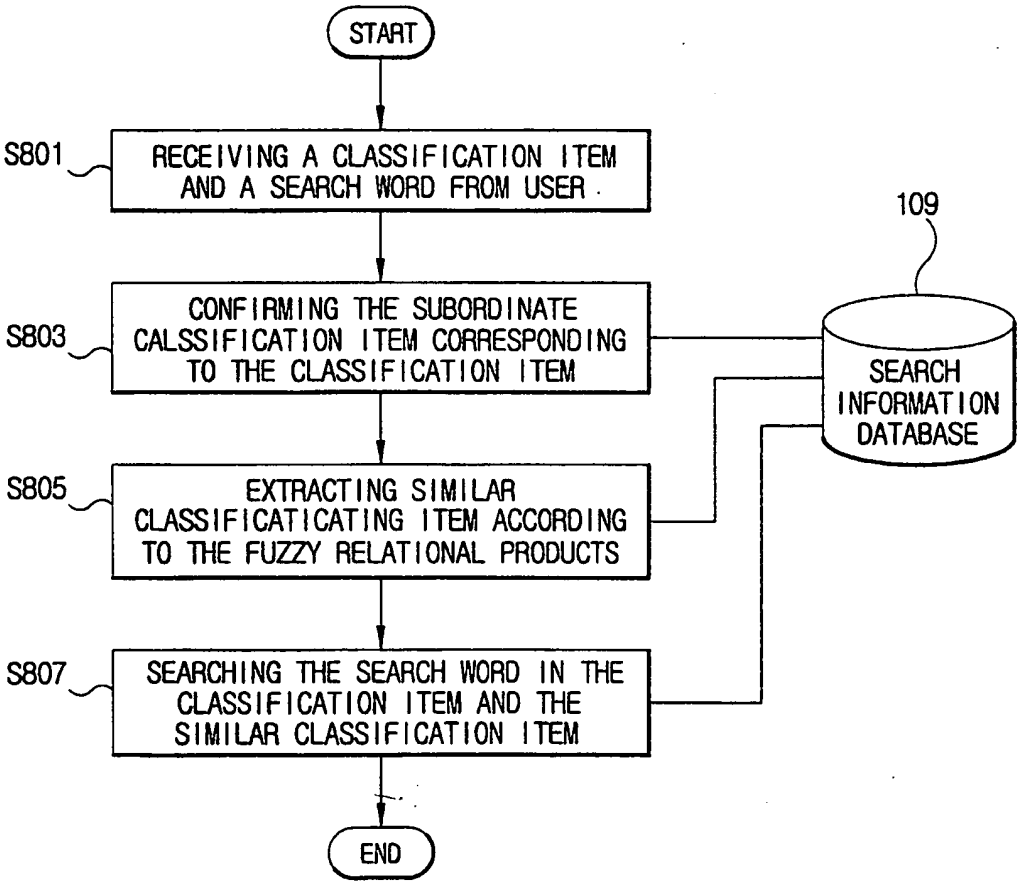


FIG. 8


START
S801
RECEIVING A CLASSIFICATION ITEM AND A SEARCH WORD FROM USER
S803
CONFIRMING THE SUBORDINATE CALSSIFICATION ITEM CORRESPONDING TO THE CLASSIFICATION ITEM
S805
EXTRACTING SIMILAR CLASSIFICATICATING ITEM ACCORDING TO THE FUZZY RELATIONAL PRODUCTS
S807
SEARCHING THE SEARCH WORD IN THE CLASSIFICATION ITEM AND THE SIMILAR CLASSIFICATION ITEM
END
109
SEARCH INFORMATION DATABASE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR02/02343

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G06F 17/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
IEEE(IEL)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5761388 A (Kohei Nomoto; Takahiro Kubo; Yoshio Kosuge) 2 June 1998 See all document.	1-16
A	US 6038560 A (Kelly Wical) 14 march 2000 See all document	1-16
A	LUCARELLA, D "Uncertainty in information retrieval: an approach based on fuzzy sets" IN : Computers and Communications, 1990. Conference Proceedings., Ninth Annual International Phoenix Conference on , 21-23 Mar 1990, Page(s): 809 -814	1-16
A	Yih-Jen Horng; Shyi-Ming Chen; Chia-Hoang Lee "A fuzzy information retrieval method using fuzzy-valued concept networks" IN : Tools with Artificial Intelligence, 1998. Proceedings. Tenth IEEE International Conference on , 10-12 Nov 1998, Page(s): 104 -111	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 MARCH 2003 (22.03.2003)	24 MARCH 2003 (24.03.2003)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	CHOI, Seung Man Telephone No. 82-42-481-5682

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR02/02343

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5,761,388 A	Jun. 02,. 1998	CA 2170452 AA JP 8234987 A2	Aug. 29, 1996 Sep. 13, 1996
US 6,038,560 A	Mar. 14, 2000	NONE	